What is claimed is:

1. A CT system for reconstructing at least one image of an object, said system comprising:

a. an x-ray source for generating x-rays, said x-ray source being mounted on a gantry for rotation about an axis;

b. an x-ray detector system mounted opposite said x-ray source for providing a set of projection data with respect to said object as the object is translated along said axis, said x-ray detector system including a plurality of rows of detector elements;

wherein for each detector element, a corresponding detector ray is defined by x-ray photons traveling from said x-ray source to said detector element; and

wherein said detector rays define an x-ray beam that is asymmetric in a plane perpendicular to said axis, said x-ray beam including a symmetric region in which one or more complementary rays can be found for each detector ray, and an asymmetric region in which no complementary ray can be found for any detector ray;

c. an interpolator for interpolating said projection data from each detector element onto a slice plane by multiplying said data with helical interpolation weights;

wherein for projection data resulting from detector rays lying within the symmetric region of said x-ray beam, the helical interpolation weights are complementary interpolation weights that weigh the data from complementary rays in proportion to the distance from each detector element row to said slice plane; and

wherein for projection data resulting from detector rays that lie within the asymmetric region of said x-ray beam, the helical interpolation weights are direct interpolation weights that weigh the data at a given azimuthal angle from different rows in proportion to the distance from each detector element row to said slice plane;

and

d. an image reconstructor for reconstructing a tomographic image of said object using said helically interpolated projection data.

2. A CT system in accordance with claim 1, wherein said plurality of rows of detector elements are substantially parallel, and wherein said substantially parallel rows are disposed side-by-side along said axis, so that during a given sampling period,

projection data can be acquired that are representative of a plurality of sections of said object.

3. A CT system in accordance with claim 1, wherein the number of said rows of detector elements is about four.

4. A CT system in accordance with claim 1, wherein for all detector rays lying within said symmetric region of said x-ray beam, the data for each detector ray and the data for its complementary rays used to interpolate the x-ray beam come from different ones of said plurality of rows of detector elements.

5. A CT system in accordance with claim 1, wherein the number of rows of detector elements is four;

wherein said rotation of said gantry defines a gantry rotation plane; and

wherein said complementary interpolation weights are defined by the relationship:

$$w_1^c(\beta,\gamma) = \alpha(x_1)\begin{cases} \dfrac{\beta - \beta_{2c}^{(-)}}{\beta_1 - \beta_{2c}^{(-)}}, & \beta_{2c}^{(-)} < \beta \le \beta_1 \\ \dfrac{\beta_{3c}^{(-)} - \beta}{\beta_{3c}^{(-)} - \beta_1}, & \beta_1 < \beta < \beta_{3c}^{(-)} \end{cases}$$

$$w_2^c(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_{3c}^{(-)}}{\beta_2 - \beta_{3c}^{(-)}}, & \beta_{3c}^{(-)} < \beta \le \beta_2 \\ \dfrac{\beta_{3c}^{(+)} - \beta}{\beta_{1c}^{(+)} - \beta_2}, & \beta_2 < \beta < \beta_{1c}^{(+)} \end{cases}$$

$$w_3^c(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_{1c}^{(+)}}{\beta_3 - \beta_{1c}^{(+)}}, & \beta_{1c}^{(+)} < \beta \le \beta_3 \\ \dfrac{\beta_{2c}^{(+)} - \beta}{\beta_{2c}^{(+)} - \beta_3}, & \beta_3 < \beta < \beta_{2c}^{(-)} \end{cases}$$

$$w_4^c(\beta,\gamma) = (1-\alpha(x_4))\begin{cases} \dfrac{\beta - \beta_{2c}^{(+)}}{\beta_4 - \beta_{2c}^{(+)}}, & \beta_{2c}^{(+)} < \beta \le \beta_4 \\ \dfrac{\beta_{3c}^{(+)} - \beta}{\beta_{3c}^{(+)} - \beta_4}, & \beta_4 < \beta < \beta_{3c}^{(+)} \end{cases}$$

where β denotes the fan angle, said fan angle being defined as the angle between a line from said x-ray source to the isocenter of said CT system, and a fixed coordinate axis in said gantry rotation plane;

β_i $(i = 1, \ldots 4)$ denotes the fan angle for the i-th row indicative of the view at which the row i is directly under the point of intersection of said slice plane with said axis of rotation;

γ denotes the angle between the projection of said detector ray on said gantry rotation plane, and a center ray disposed in the center of said x-ray beam;

$w_i^c(\beta, \gamma)$ $(i = 1, \ldots 4)$ denotes the complementary interpolation weight for a detector element in the i-th row and ray angle γ with respect to said center ray, at a fan angle β;

β_{ic} $(i = 1, \ldots 4)$ denotes the fan angle of a ray complementary to the ray at β_i, γ;

(+) indicates that said complementary ray comes from a current rotation;

(-) indicates that said complementary ray comes from a previous rotation;

and

$$\alpha(x) = 3x^2 - 2x^3, x_1 = \frac{\beta - \beta_{2c}^{(1)}}{\beta_{3c}^{(-)} - \beta_{2c}^{(-)}} \text{ and } x_4 = \frac{\beta - \beta_{2c}^{+}}{\beta_{3c}^{(+)} - \beta_{2c}^{(+)}}.$$

6. A CT system in accordance with claim 1, wherein the number of rows of detector elements is four, and

wherein said direct interpolation weights are defined by the relationship:

$$w_1^d(\beta,\gamma) = \begin{cases} \alpha(x_1)\left(1 - \dfrac{\beta_1 - \beta}{\beta_2 - \beta_1}\right), & \beta_{2c}^{(-)} < \beta \leq \beta_1 \\ \alpha(x_1)\dfrac{\beta_2 - \beta}{\beta_2 - \beta_1}, & \beta < \beta \leq B_{3c}^{(-)} \\ \dfrac{\beta_2 - \beta}{\beta_2 - \beta_1}, & \beta_{3c}^{(-)} < \beta \leq \beta_2 \end{cases}$$

$$w_2^d(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_1}{\beta_2 - \beta_1}, \beta_1 < \beta \leq \beta_2 \\ \dfrac{\beta_3 - \beta}{\beta_3 - \beta_2}, \beta_2 < \beta < \beta_3 \end{cases}$$

$$w_3^d(\beta,\gamma)=\begin{cases}\dfrac{\beta-\beta_2}{\beta_3-\beta_2}, & \beta_2<\beta\le\beta_3\\ \dfrac{\beta_4-\beta}{\beta_4-\beta_3}, & \beta_3<\beta<\beta_4\end{cases}$$

$$w_4^d(\beta,\gamma)=\begin{cases}\dfrac{\beta-\beta_3}{\beta_4-\beta_3}, & \beta_3<\beta\le\beta_{2c}^{(+)}\\ (1-\alpha(x_4))\dfrac{\beta-\beta_3}{\beta_4-\beta_3}, & \beta_{2c}^{(+)}<\beta\le\beta_4\\ (1-\alpha(x_4))\left(1-\dfrac{\beta-\beta_4}{\beta_4-\beta_3},\right) & \beta_4<\beta\le\beta_{3c}^{(+)}\end{cases}$$

and where β, β_i $(i = 1, \ldots 4)$, γ, $w_i^c(\beta, \gamma)$ $(i = 1, \ldots 4)$,

β_{ic} $(i = 1, \ldots 4)$, $(+)$, $(-)$, $\alpha(x)$, x_1, and

x_4 are defined as in claim 5.

7. A CT system in accordance with claim 1,
wherein said x-ray beam further comprises at least one blending region within said symmetric region adjacent to the boundary between said symmetric region and said asymmetric region, and

wherein for projection data resulting from detector rays lying within said blending region, the helical interpolation weights are blending interpolation weights created by a combination of direction and complementary interpolation weights.

8. A CT system in accordance with claim 7, wherein said blending region occurs at γ angle ranges between (γ_b, γ_s), and $(-\gamma_b, -\gamma_s)$, where γ_b represents the value of γ at the start of said blending region within said symmetric region of said x-ray beam, and γ_s represents the value of γ at said boundary between said symmetric region and said asymmetric region.

9. A CT system in accordance with claim 7, wherein said blending interpolation weights are defined by the following relationship:

within the range (γ_b, γ_s),

$$w_i(\beta,\gamma) = (1-\alpha_f(x))w_i^c(\beta,\gamma) + \alpha_f(x)w_i^d(\beta,\gamma);$$

within the range $(-\gamma_s, -\gamma_b)$,

$$w_i(\beta,\gamma) = (1-\alpha_f(x))w_i^c(\beta,\gamma);$$

where $\alpha_f(x) = 3x^3 - 2x^2$ and $1 \leq i \leq 4$, and

$$x = \frac{\gamma - \gamma_b}{\gamma_s - \gamma_b}.$$

10. A CT system in accordance with claim 1, wherein said image reconstructor includes means for performing 2D (two-dimensional) backprojection of said helically interpolated projection data.

11. A CT system in accordance with claim 1, wherein said x-ray beam comprises a plurality of fan-shaped beams.

12. A CT system in accordance with claim 1, wherein said translation of said object along said axis occurs at a constant speed.

13. A CT system in accordance with claim 1, wherein the angular range of the weighted projection data is greater than 2π.

14. A CT system in accordance with claim 1, wherein said helical interpolator includes an interpolation weight generator for generating said helical interpolation weights.

15. A CT system in accordance with claim 1, wherein for all detector rays lying within said symmetric region of said x-ray beam, the data for each detector ray and the data for its complementary rays used to interpolate the x-ray beam come from every one of said plurality of rows of detector elements.

16. A method of reconstructing at least one image of an object, the method comprising:

a. helically scanning said object with x-rays to acquire tomographic projection data representative of said object while said object is translated along an axis, said x-rays being generated by an x-ray source mounted on a gantry for rotation about said axis, said x-rays being incident upon a multi-slice x-ray detector system having a plurality of substantially parallel rows of detector elements;

wherein for each detector element, a corresponding detector ray is defined by x-ray photons traveling from said x-ray source to said detector element; and

wherein said detector rays define an x-ray beam that is asymmetric in a plane perpendicular to said axis, said x-ray beam including a symmetric region in which one or more complementary rays can be found for each detector ray, and an asymmetric region in which no complementary ray can be found for any detector ray;

b. helically interpolating the projection data of the detector elements by multiplying the data with helical interpolation weights;

wherein for projection data resulting from detector rays lying within the symmetric region of said x-ray beam, the helical interpolation weights are complementary interpolation weights that weigh the data from complementary rays in proportion to the distance from each detector element row to said slice plane; and

wherein for projection data resulting from detector rays that lie within the asymmetric region of said x-ray beam, the helical interpolation weights are direct interpolation weights that weigh the data at a given azimuthal angle from different rows in proportion to the distance from each detector element row to said slice plane; and

c. reconstructing a tomographic image of said object, using said helically interpolated projection data.

17. A method in accordance with claim 16, wherein said plurality of rows of detector elements are substantially parallel, and wherein said substantially parallel rows are disposed side-by-side along said axis, so that during a given sampling period, projection data can be acquired that are representative of a plurality of sections of said object.

18. A method in accordance with claim 16, wherein for all detector rays lying within said symmetric region, the data for each detector ray and the data for its complementary ray used to interpolate the x-ray beam come from different ones of said plurality of rows of detector elements.

19. A method in accordance with claim 16, wherein for all detector rays lying within said symmetric region of said x-ray beam, the data for each detector ray and the data for its complementary rays used to interpolate the x-ray beam come from every one of said plurality of rows of detector elements.

20. A method in accordance with claim 16, wherein the number of rows of detector elements is four;

wherein said rotation of said gantry defines a gantry rotation plane; and

wherein said complementary interpolation weights are defined by the relationship:

$$w_1^c(\beta,\gamma) = \alpha(x_1)\begin{cases} \dfrac{\beta - \beta_{2c}^{(-)}}{\beta_1 - \beta_{2c}^{(-)}}, & \beta_{2c}^{(-)} < \beta \le \beta_1 \\ \dfrac{\beta_{3c}^{(-)} - \beta}{\beta_{3c}^{(-)} - \beta_1}, & \beta_1 < \beta < \beta_{3c}^{(-)} \end{cases}$$

$$w_2^c(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_{3c}^{(-)}}{\beta_2 - \beta_{3c}^{(-)}}, & \beta_{3c}^{(-)} < \beta \le \beta_2 \\ \dfrac{\beta_{3c}^{(+)} - \beta}{\beta_{1c}^{(+)} - \beta_2}, & \beta_2 < \beta < \beta_{1c}^{(+)} \end{cases}$$

$$w_3^c(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_{1c}^{(+)}}{\beta_3 - \beta_{1c}^{(+)}}, & \beta_{1c}^{(+)} < \beta \le \beta_3 \\ \dfrac{\beta_{2c}^{(+)} - \beta}{\beta_{2c}^{(+)} - \beta_3}, & \beta_3 < \beta < \beta_{2c}^{(-)} \end{cases}$$

$$w_4^c(\beta,\gamma) = (1-\alpha(x_4))\begin{cases} \dfrac{\beta - \beta_{2c}^{(+)}}{\beta_4 - \beta_{2c}^{(+)}}, & \beta_{2c}^{(+)} < \beta \le \beta_4 \\ \dfrac{\beta_{3c}^{(+)} - \beta}{\beta_{3c}^{(+)} - \beta_4}, & \beta_4 < \beta < \beta_{3c}^{(+)} \end{cases}$$

where β denotes the fan angle, said fan angle being defined as the angle between a line from said x-ray source to the isocenter of said CT system, and a fixed coordinate axis in said gantry rotation plane;

β_i ($i = 1, \ldots 4$) denotes the fan angle for the i-th row indicative of the view at which the row i is directly under the point of intersection of said slice plane with said axis of rotation;

γ denotes the angle between the projection of a detector ray onto said gantry rotation plane and a center ray disposed in the center of said x-ray beam;

$w_i^c(\beta, \gamma)$ ($i = 1, \ldots 4$) denotes the complementary interpolation weight for a detector element in the i-th row and ray angle γ with respect to said center ray, at a fan angle β;

β_{ic} ($i = 1, \ldots 4$) denotes the fan angle of a ray complementary to the ray at β_i, γ,

(+) indicates that said complementary ray comes from a current rotation;

(-) indicates that said complementary ray comes from a previous rotation;

and

$$\alpha(x) = 3x^2 - 2x^3, x_1 = \frac{\beta - \beta_{2c}^{(1)}}{\beta_{3c}^{(-)} - \beta_{2c}^{(-)}} \text{ and } x_4 = \frac{\beta - \beta_{2c}^{+}}{\beta_{3c}^{(+)} - \beta_{2c}^{(+)}}.$$

21. A method in accordance with claim 16, wherein the number of rows of detector elements is four, and

wherein said direct interpolation weights are defined by the relationship:

$$w_1^d(\beta, \gamma) = \begin{cases} \alpha(x_1)\left(1 - \dfrac{\beta_1 - \beta}{\beta_2 - \beta_1}\right), & \beta_{2c}^{(-)} < \beta \le \beta_1 \\ \alpha(x_1)\dfrac{\beta_2 - \beta}{\beta_2 - \beta_1}, & \beta < \beta \le B_{3c}^{(-)} \\ \dfrac{\beta_2 - \beta}{\beta_2 - \beta_1}, & \beta_{3c}^{(-)} < \beta \le \beta_2 \end{cases}$$

$$w_2^d(\beta, \gamma) = \begin{cases} \dfrac{\beta - \beta_1}{\beta_2 - \beta_1}, & \beta_1 < \beta \le \beta_2 \\ \dfrac{\beta_3 - \beta}{\beta_3 - \beta_2}, & \beta_2 < \beta < \beta_3 \end{cases}$$

$$w_3^d(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_2}{\beta_3 - \beta_2}, & \beta_2 < \beta \le \beta_3 \\ \dfrac{\beta_4 - \beta}{\beta_4 - \beta_3}, & \beta_3 < \beta < \beta_4 \end{cases}$$

$$w_4^d(\beta,\gamma) = \begin{cases} \dfrac{\beta - \beta_3}{\beta_4 - \beta_3}, & \beta_3 < \beta \le \beta_{2c}^{(+)} \\ (1-\alpha(x_4))\dfrac{\beta - \beta_3}{\beta_4 - \beta_3}, & \beta_{2c}^{(+)} < \beta \le \beta_4 \\ (1-\alpha(x_4))\left(1 - \dfrac{\beta - \beta_4}{\beta_4 - \beta_3},\right) & \beta_4 < \beta \le \beta_{3c}^{(+)} \end{cases}$$

and where β, β_i $(i = 1, \ldots 4)$, γ, $w_i^c(\beta, \gamma)$ $(i = 1, \ldots 4)$,

β_{ic} $(i = 1, \ldots 4)$, (+), (-), $\alpha(x)$, x_1, and

x_4 are defined as in claim 20.

22. A method in accordance with claim 16, wherein the step of reconstructing said image of said object includes the step of performing a 2D (two-dimensional) backprojection of said helically interpolated projection data.

23. A method in accordance with claim 16, wherein said x-ray beam further comprises at least one blending region that is contained within said symmetric region and that is proximate to the boundary between said symmetric region and said asymmetric region, and

wherein for projection data resulting from detector rays lying within said blending region, the helical interpolation weights are blending interpolation weights created by a combination of direct and complementary interpolation weights.

24. A method in accordance with claim 23, wherein said blending region occurs at γ angle ranges between (γ_b, γ_s), and $(-\gamma_b, -\gamma_s)$, where γ_b represents the value of γ at the start of said blending region within said symmetric region of said x-ray beam, and γ_s represents the value of γ at said boundary between said symmetric region and said asymmetric region; and

wherein said blending interpolation weights are defined by the following relationship:

within the range (γ_b, γ_s),

$$w_i(\beta,\gamma) = (1-\alpha_f(x))w_i^c(\beta,\gamma) + \alpha_f(x)w_i^d(\beta,\gamma);$$

within the range $(-\gamma_s, -\gamma_b)$,

$$w_i(\beta,\gamma) = (1-\alpha_f(x))w_i^c(\beta,\gamma);$$

where $\alpha_f(x) = 3x^3 - 2x^2$ and $1 \le i \le 4$, and

$$x = \frac{\gamma - \gamma_b}{\gamma_s - \gamma_b}.$$